Sensing the World Around You – With Linux and other bits

Brian DeLacey

BLU @ MIT, 5/20/2015

Agenda

- 6:30 - 7:15 - Jerry and John, open BLU discussion
- 7:15 - 7:45 - Zigurd Mednieks, "Orders-of-magnitude-advances in Sensing Technology"
- 7:45 - 8:30 - Brian DeLacey, Technical hands on hacking with sensors and TI's new MSP432 on Linux
- 8:30 - 9:00 – Discussion – Arun, Zigurd, Brian, All
  - General Questions
  - Sensing technology and IoT
  - What is the O/S for the Sensing world?
  - Give Away Items thanks to Texas Instruments

Details and Recap at http://blu.org/cgi-bin/calendar/2015-jun

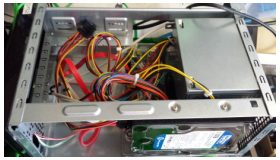
Spoiler Alert: Lessons Learned

- Familiar and Fun
- Relatively Low Cost
- Vast Introduction to Landscape of
  - Computers / Hardware
  - Electronics
  - Programming / Software
  - Communications / Radios / Wireless
  - Real-world, Sensor-based applications
- Some tricks you'll learn on the fly
  - Flaky cables, shared power rails, beware the motors

Manage Data Locally While Sharing Globally
With User-Controlled Programs and Preferences

End Result: IoT Network Topology

Actiontec MI424WR GigE
192.168.1.1



Linux Box
192.168.6.30

TP-LINK TL-WDR3500 Wireless
N600 Dual Band Router
OpenWrt
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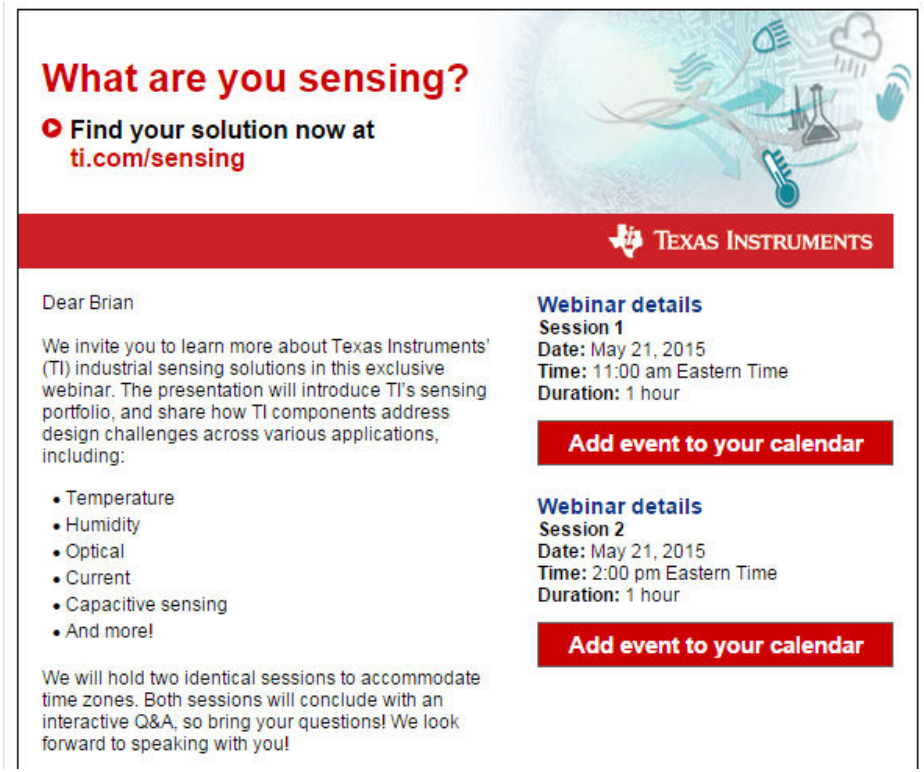
192.168.6.10
TI SimpleLink Wi-Fi
CC3200 LaunchPad

192.168.6.20
TI MSP432
LaunchPad
CC3100 WiFi

http://www.ti.com/sensing

What are you sensing?



http://links.mkt102.com/servlet/MailView?ms=NDg2OTg4MjUS1&r=MTE1NzI3MTE2NjE4S0&j=NjgyNDcyNzY0S0&mt=1&rt=0

http://www.ti.com/sensors

Texas Instruments - Sensing

CC2650STK-SimpleLink™ Bluetooth Smart®/Multi-Standard SensorTag

TI Sensor Tag

- Infrared and Ambient Temperature Sensor
- Ambient Light Sensor
- Humidity Sensor
- Barometric Pressure Sensor
- 9- axis Motion Tracking Device – Accelerometer, Gyroscope and Compass
- Magnet Sensor

	Bluetooth Smart	6LoWPAN	ZigBee
Price	$29 Buy Now	$29 Buy Now	$29 Buy Now
Battery type	Coin cell	Coin cell	Coin cell
Connects to Internet	Smartphone	BeagleBone gateway	BeagleBone gateway
Beacon support	✓		
DevPack support	✓	✓	✓
Mesh network		✓	✓
Range	50m / 150ft	100m / 300ft (extended with mesh network)	100m / 300ft (extended with mesh network)
Max number of devices	8	200	200
Battery lifetime*	1 year (1 second report interval)	1 year (1 second report interval)	1 year (1 second report interval)
User Interface	App	App, Web	App, Web

http://www.ti.com/ww/en/wireless_connectivity/sensortag2015

Internet of (some) things

"In 2015, a modern-day gold rush has taken the technology sector by storm."

"The solution lies not in the internet of *everything*, but rather the internet of *some things,* which may include brand-new investments in new "smart" assets. Or more likely, tapping into existing sensor networks and equipment with embedded intelligence which have been sitting idle."

http://techcrunch.com/2015/05/19/the-internet-of-some-things/#.ffl8cn:OFBk

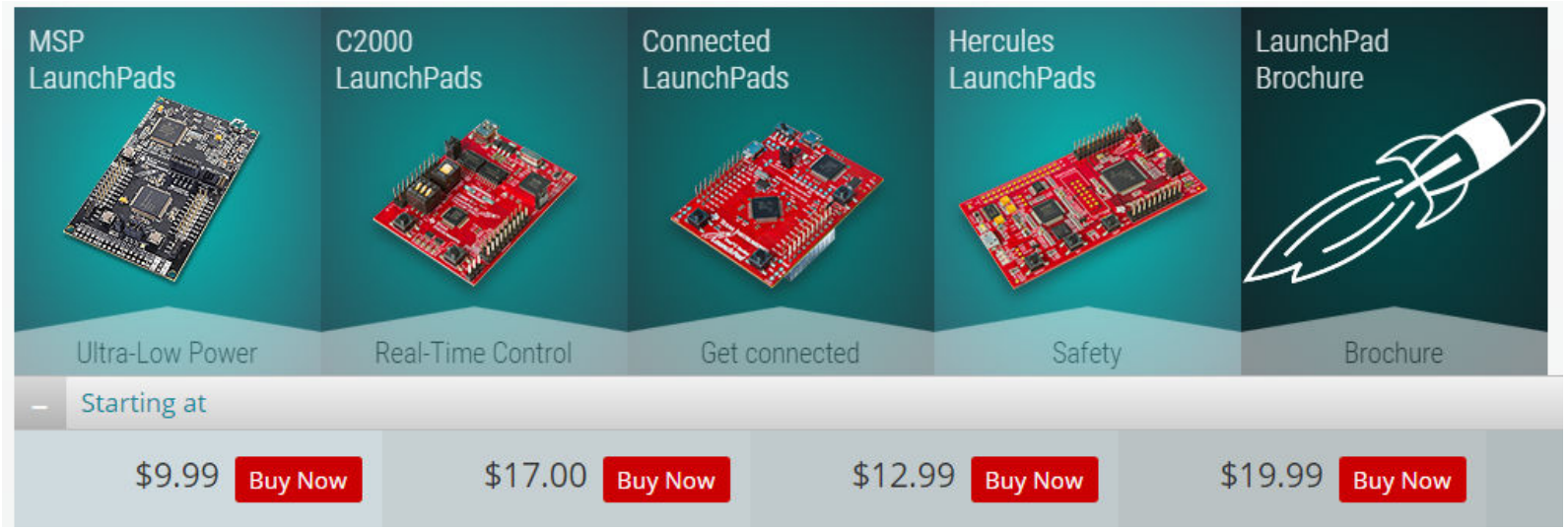
Data Mining, in your backyard

1. C4.5
2. k-means
3. Support vector machines
4. Apriori
5. EM
6. PageRank
7. AdaBoost
8. kNN
9. Naive Bayes
10. CART

A really good overview …

http://rayli.net/blog/data/top-10-data-mining-algorithms-in-plain-english/

LaunchPad EcoSystem

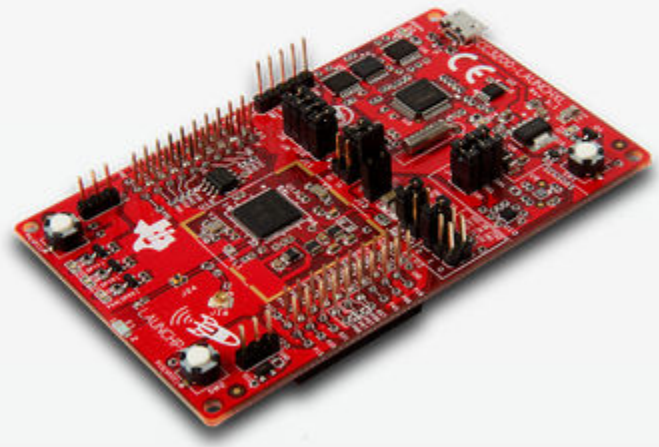


http://www.ti.com/ww/en/launchpad/launchpads.html

Let's focus on these two …

CC3200-LAUNCHXL

$29.99



MSP-EXP432P401R

$12.99

http://www.ti.com/ww/en/launchpad/launchpads-connected-cc3200-launchxl.html#tabs

http://www.ti.com/ww/en/launchpad/launchpads-msp430-msp-exp432p401r.html#tabs

And programming with Energia…

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Prototyping Software to Make Things Easy

03/24/2015 – Energia 15 is available!. The release is available for download from here.

Aside from bug fixes this release adds support for the new ARM Cortex M4F based MSP432 LaunchPad. This time it's a bit different though! The framework is powered by TI-RTOS letting you run your Sketches in parallel. Yes, in parallel! How awesome is that?!. This release supports MT for the MSP432 LaunchPad with other boards support coming in future releases. Find out more about multitasking @ Energia MT

So, what is this all about then?

Energia is an open-source electronics prototyping platform started by Robert Wessels in January of 2012 with the goal to bring the Wiring and Arduino framework to the Texas Instruments MSP430 based LaunchPad. The Energia IDE is cross platform and supported on Mac OS, Windows, and Linux. Energia uses the mspgcc compiler by Peter Bigot and is based on the Wiring and Arduino framework. Energia includes an integrated development environment (IDE) that is based on Processing.

Search Energia …

Search

Official 430h Energia Forum

Energia Source Code

Energia GitHub Wiki

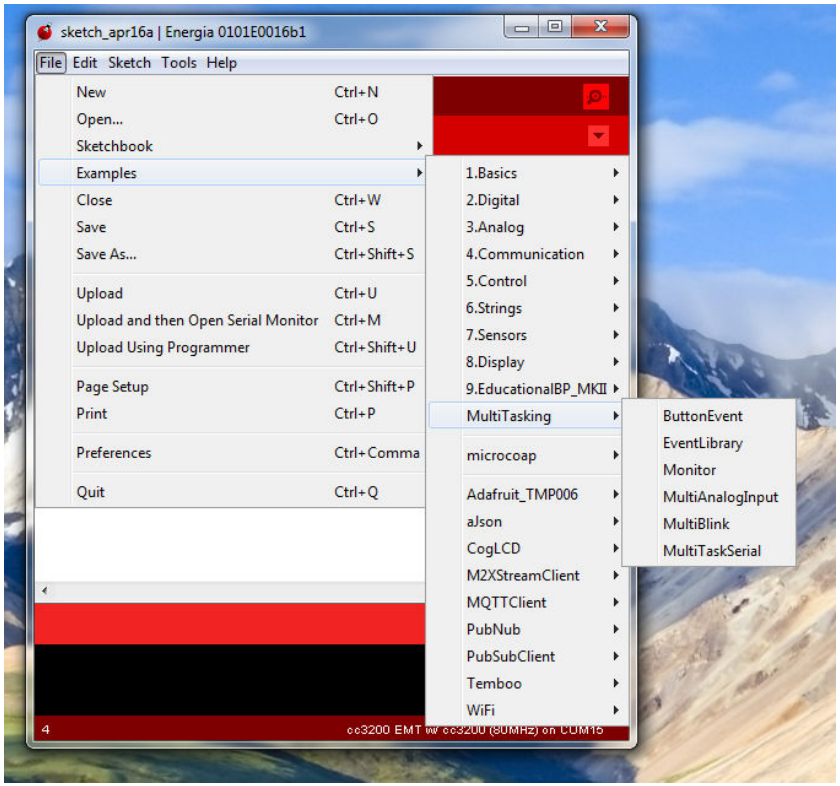
Energia API References

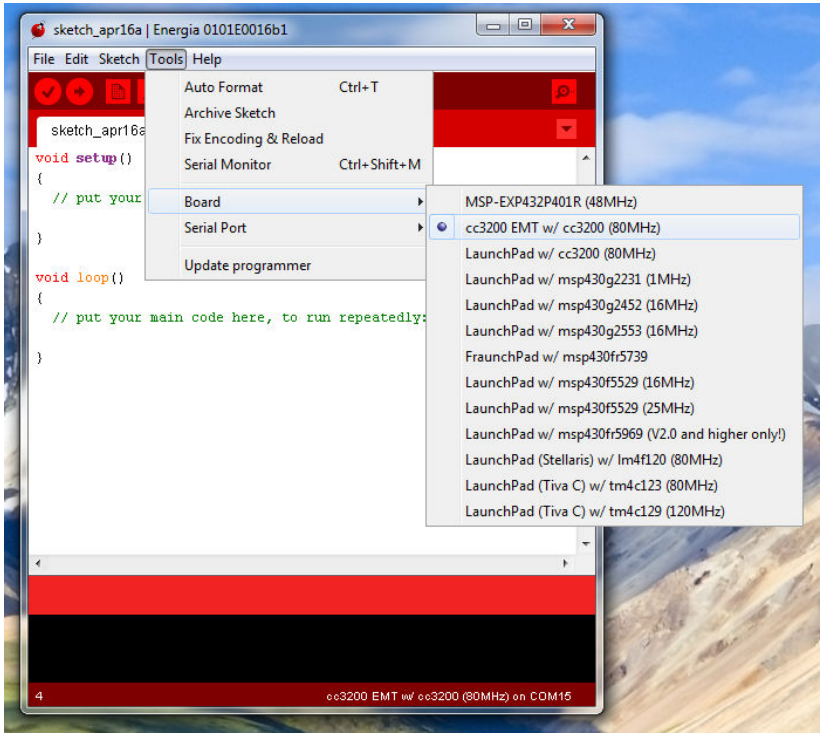
Energia Libraries

LaunchPad Pin Mapping and Board Setup Instructions:

- C2000 F28027 LaunchPad
- CC3200 WiFi LaunchPad
- MSP430F5529 LaunchPad
- MSP430FR5739 Experimenter
- MSP430FR5969 LaunchPad

Installing Energia MT for TI-RTOS





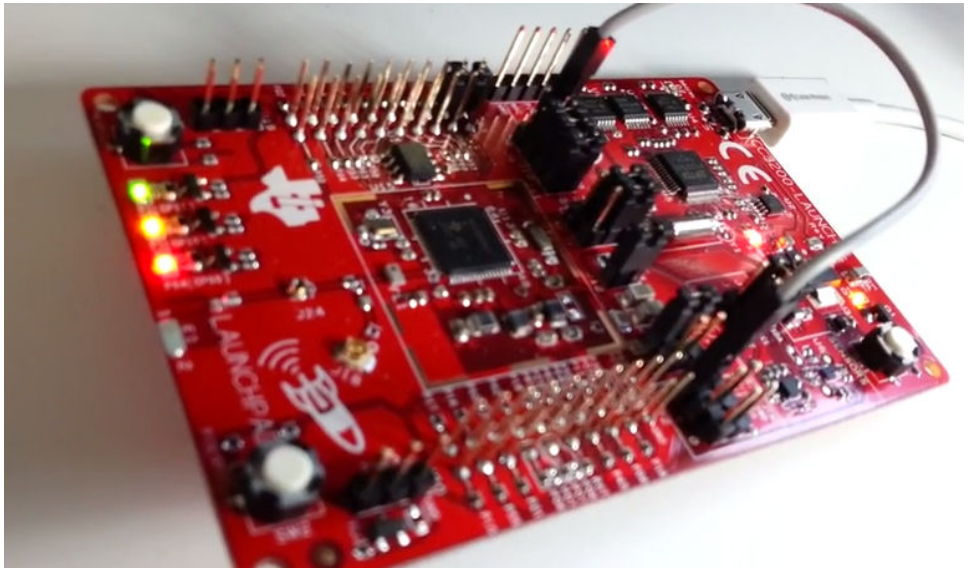
Multi-Tasking Real-Time Operating System with low-cost SOCs

Energīa

Home | Download | Guide | Reference | Blog | Store | Getting Help | IRC | Energia Projects | Eve

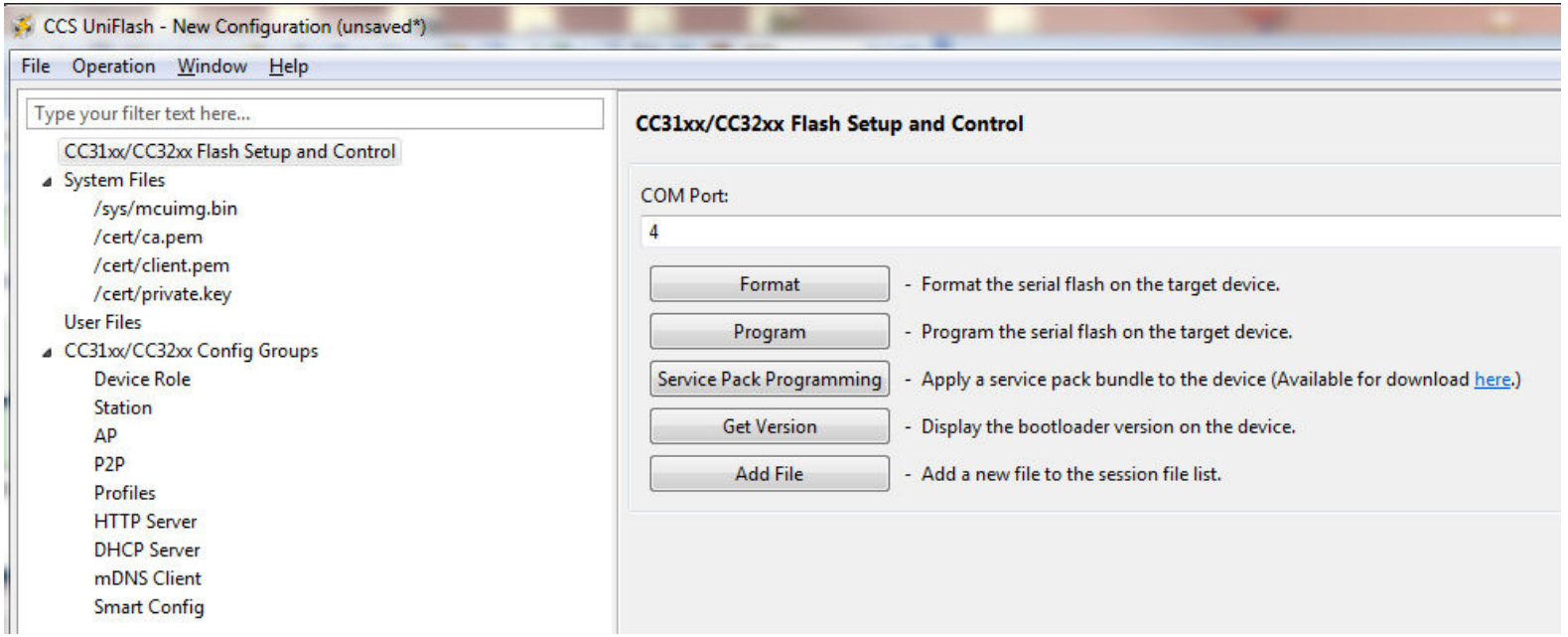
Multitasking

Multitasking is the ability to run multiple tasks or threads concurrently on a microcontroller. In Energia MT, multitasking is achieved by treating each tab as a separate task and letting TI-RTOS and Energia take care of the rest. Currently, Multitasking is supported on the MSP432 launchpad.



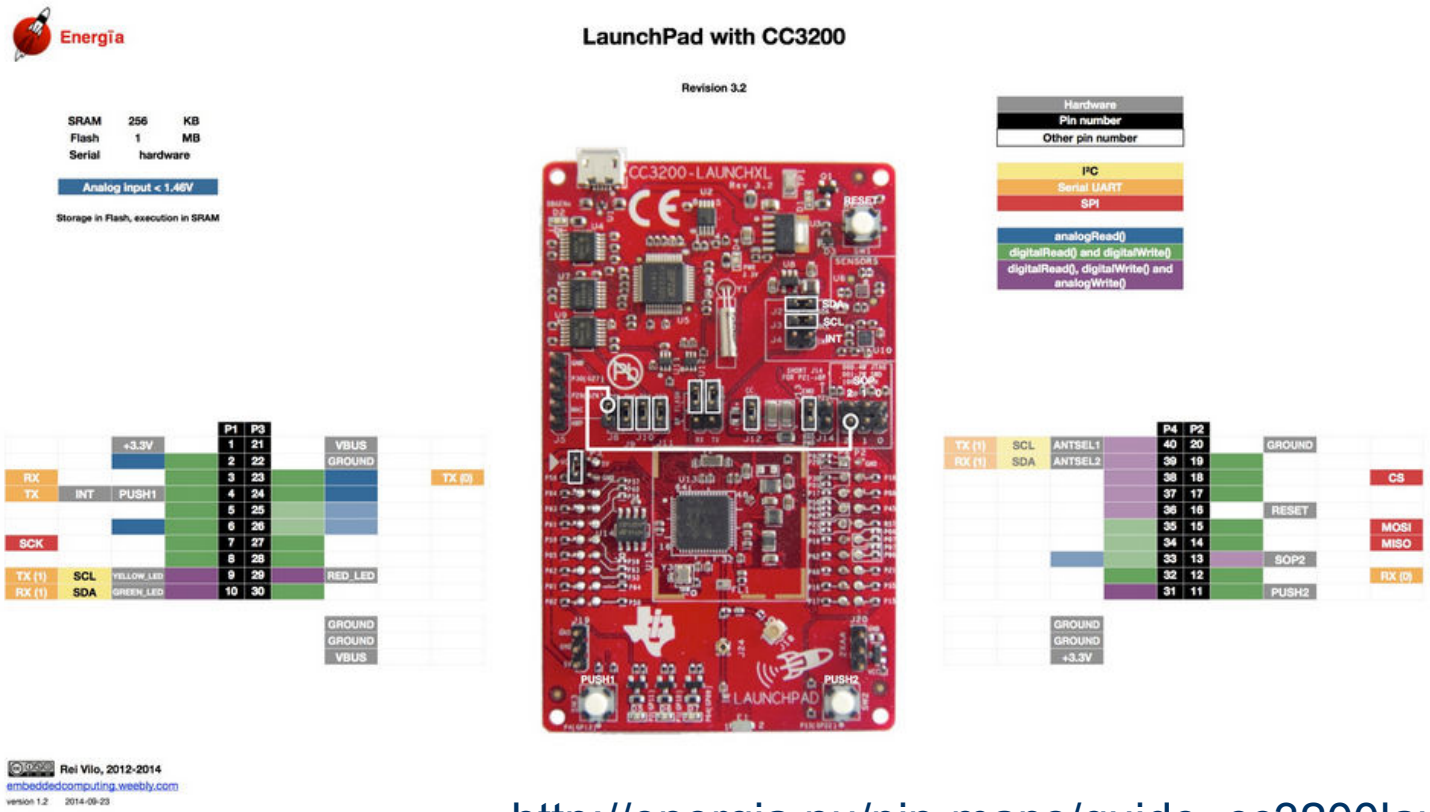
http://energia.nu/guide/multitasking/

Maybe, Some Configuration



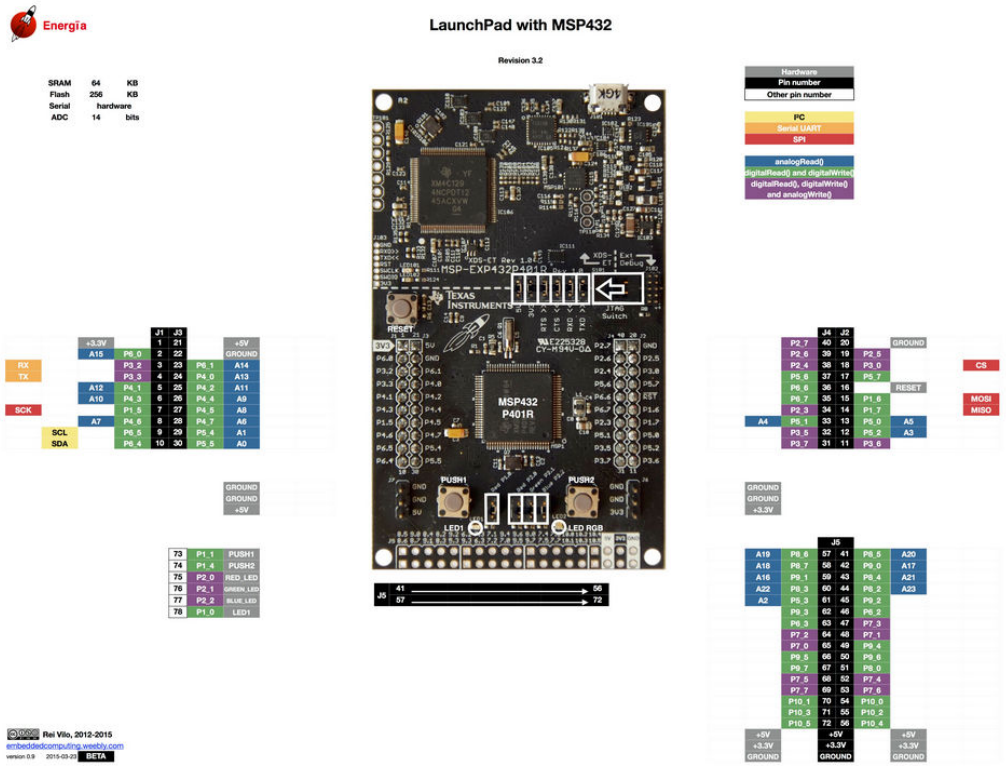
[File,New Configuration]
Then click on “Service Pack Programming”
When you are prompted to restart, just press the RESET button (SW1)

Pin Mapping – CC3200



http://energia.nu/pin-maps/guide_cc3200launchpad/

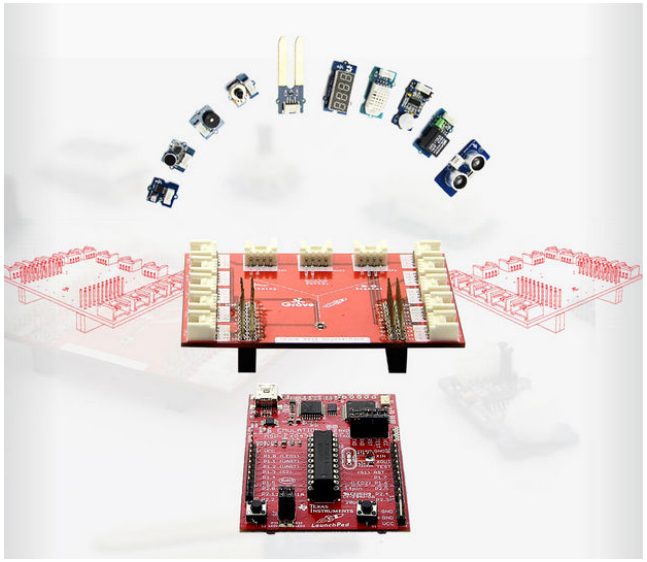
Pin Mapping – MSP432



http://energia.nu/pin-maps/guide_msp432p401r/

What are BoosterPacks?

SimpleLink Wi-Fi CC3100
$19.99



Grove Starter Kit for LaunchPad
$59

http://www.ti.com/tool/cc3100boost

http://www.seeedstudio.com/depot/Grove-Starter-Kit-for-LaunchPad-p-2178.html

BP	Connected to CC3100, used by Energia
BP-NA	Connected to CC3100, but not used by Energia
SU	Serial UART
SPI	SPI
AR	Analog Read
DR-DW	digitalRead and digitalWrite
DR-DW-AW	digitalRead and digitalWrite and analogWrite

Example App Pin Mappings

MSP432

#	System	My App
1	**BP**	
2	*DR-DW*	
3	**BP-NA**	
4	**BP-NA**	
5	**BP-NA**	
6	*DR-DW*	
7	**BP**	
8	*DR-DW*	
9	*DR-DW*	
10	*DR-DW*	

#	System	My App
21	5V	
22	GROUND	
23	*DR-DW or AR*	*RED_BUTTON*
24	*DR-DW or AR*	*YELLOW_BUTTON*
25	*DR-DW or AR*	*GREEN_BUTTON*
26	*DR-DW or AR*	*BLUE_BUTTON*
27	*DR-DW or AR*	
28	*DR-DW or AR*	
29	*DR-DW or AR*	*POT_1*
30	*DR-DW or AR*	*POT_2*

#	System	My App
40	DR-DW-AW	
39	DR-DW-AW	
38	DR-DW-AW	
37	**BP-NA**	
36	DR-DW	
35	**BP-NA**	
34	**BP-NA**	
33	**BP-NA**	
32	DR-DW-AW	
31	DR-DW-AW	*BUZZER*

#	System	My App
20	**BP**	
19	**BP**	
18	**BP**	
17	DR-DW	
16	RESET	
15	**BP**	
14	**BP**	
13	DR-DW	*PIR*
12	DR-DW	*YELLOW_LED*
11	DR-DW-AW	

CC3200

#	System	App
1	**BP**	
2	*DR-DW*	
3	**BP-NA**	*RED_BUTTON*
4	**BP-NA**	*YELLOW_BUTTON*
5	**BP-NA**	*GREEN_BUTTON*
6	*DR-DW*	*BLUE_BUTTON*
7	**BP**	
8	*DR-DW*	*PIR*
9	*DR-DW*	
10	*DR-DW*	

#	System	My App
21	5V	
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39	DR-DW-AW	
38	DR-DW-AW	
37	**BP-NA**	
36	DR-DW	
35	**BP-NA**	
34	**BP-NA**	
33	**BP-NA**	
32	DR-DW-AW	
31	DR-DW-AW	*BUZZER*

#	System	My App
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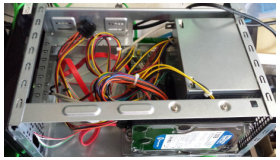
19	**BP**	
18	**BP**	
17	DR-DW	
16	RESET	
15	**BP**	
14	**BP**	
13	DR-DW	
12	DR-DW	*YELLOW_LED*
11	DR-DW-AW	

Manage Data Locally While Sharing Globally
With User-Controlled Programs and Preferences

Weave it into IoT Network Topology

Actiontec MI424WR GigE
192.168.1.1



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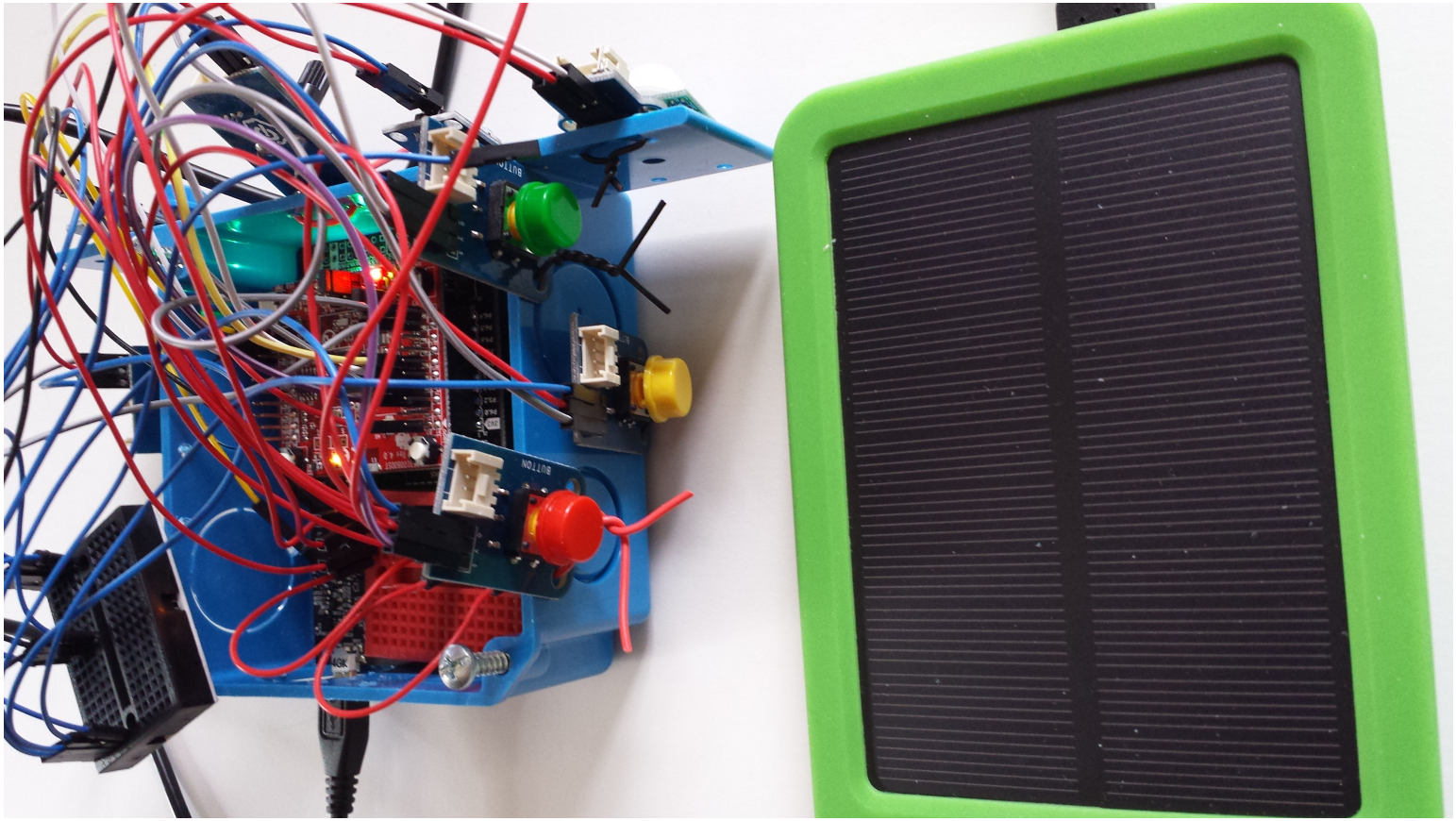
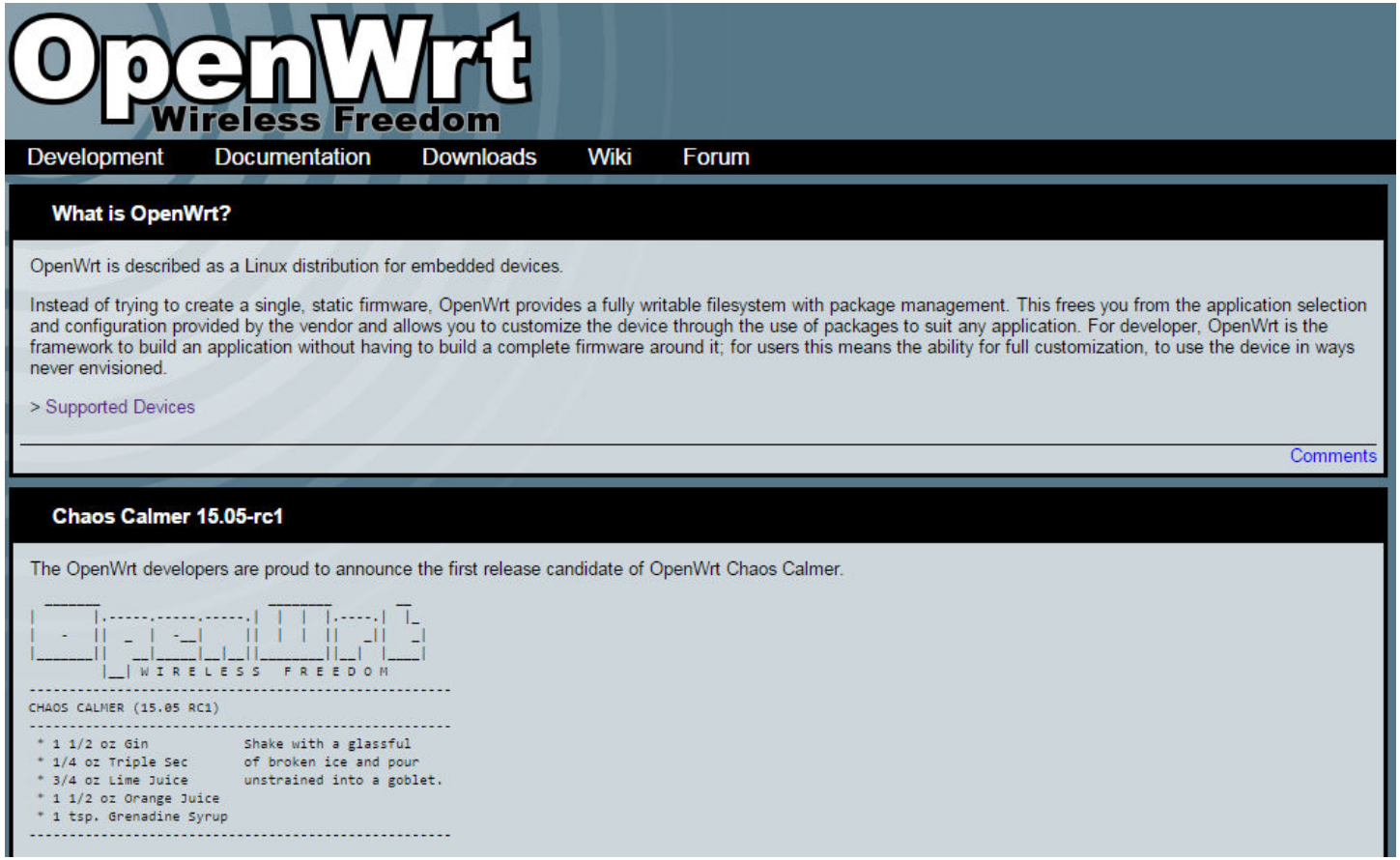
TI MSP432
LaunchPad
CC3100 WiFi

Energy Efficient - Try Solar!



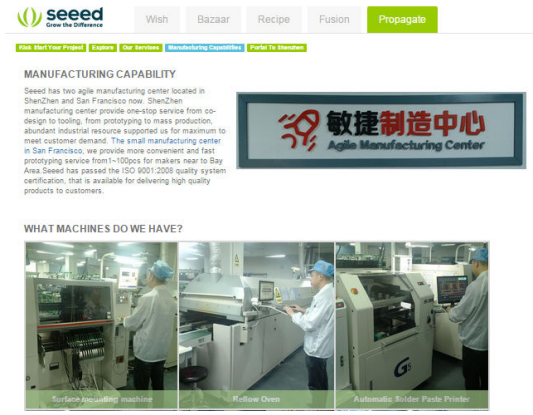
“OpenWrt is described as a Linux distribution for embedded devices.”



Energia Futures

- Addition of Libraries
  - Tone()
- Support for additional LaunchPads
  - CC3200
  - SensorTag
- Future is Multi-Tasking
  - No new “native” ports, but some single-task optimizations when running TI-RTOS
- And more goodness …

Where to find parts? Sensors?



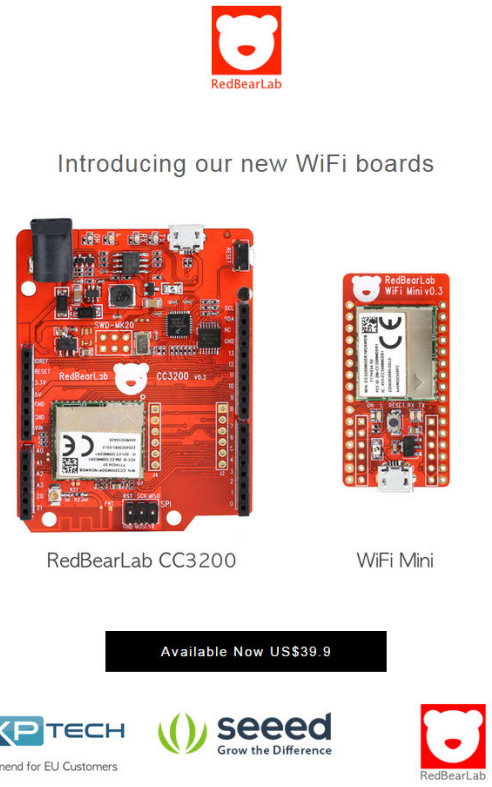
Colored buttons from http://www.adafruit.com

jumper cables and accessories from Amazon.com

Sensors and Electronic Bricks from http://www.seeedstudio.com and http://imall.iteadstudio.com/prototyping/electronic-brick.html

Think Modules too …

Red Bear Labs



http://redbearlab.com/

Lessons Learned

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- Some tricks you'll learn on the fly
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Q&A - Panel

- "What is the operating system of the sensor world?"
- Panel Discussion
  - Zigurd Mednieks
  - Arun Thomas
  - Brian DeLacey

Next Month, Next Meeting

Kurt and team were away
for this meeting competing
in Taiyuan City, China with the
Asia SuperComputer Community.

Kurt returns for the 6/17/15
Meeting to talk about

Linux in Supercomputing: Trends
in High Performance Computing